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Performance Monitoring, Fault Detection, Fault Localization Design Guidance

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Engineering & Technical
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PREFACE

This technical report was prepared under Project No. A23603, "Surface Ship Torpedo Defense," Principal Investigator Howard J. Phelps (Code 3332). The sponsoring activity is the Naval Sea Systems Command, Captain E. Graham (PMS-415).

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SUMMARY

Performance Monitoring, Fault Detection and Fault Localization (PM/FD/FL) in large complex systems is a growing discipline that overwhelms the more familiar Built In Test (BIT) process. At present, this field is generally underestimated and unstandardized. In several recent instances, lack of a detailed design approach has led to unsatisfactory add-on PM/FD/FL functions to systems.

This report contains a standardized approach to the acquisition of PM/FD/FL functions and a discussion of the optimization of these functions. It is expected that a standardized approach will ensure the development of acceptable PM/FD/FL functions within budget, schedule, and in phase with other system development efforts. The discussion will instill an appreciation for the complexity of PM/FD/FL development and provide assistance in optimizing the process.

An introduction to PM/FD/FL, an in-depth plan for development program elements and tasks, and several appendices, (A through E) including one on the optimization of PM/FD/FL development is presented.



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PERFORMANCE MONITORING, FAULT DETECTION, FAULT LOCALIZATION DESIGN GUIDANCE

SECTION I INTRODUCTION

ADVERSE TRENDS

The complexity, size, required performance, and the need for rapid recovery from hardware and software malfunctions of our military systems are steadily increasing, while both the manning and skill levels of our operating forces are decreasing. This combination of events may result in unmanageable maintenance and logistics burdens unless compensating provisions are introduced. One possible compensating provision is the inclusion of highly effective Performance Monitoring, Fault Detection, and Fault Localization (PM/FD/FL) functions in new systems. The fielding of some recent systems containing far from optimal PM/FD/FL functions indicates that this will not be a compensating provision unless improvements are made in the way PM/FD/FL functions are developed.

Experience has shown that after systems become fully operational a number of problems are likely to emerge, and there must be an orderly, timely, and cost effective manner of handling them. Problems continue to emerge as systems mature, and many of these pose almost insurmountable difficulties to the maintenance technicians. The less capable the PM/FD/FL functions, the more difficult these problems become. These problems are made even more difficult by the rapid turn-over of highly skilled maintenance personnel.

REVERSING THE TRENDS

The threatening trends can be minimized by the incorporation of highly effective automated PM/FD/FL functions in complex systems. The problem is to select a methodology that ensures effectiveness. This report contains a standardized methodology for ensuring development of highly effective PM/FD/FL functions. It also contains some guidance on the selection of PM/FD/FL parameters and optimization of the functions. Application of the standardized methodology and the optimization suggestions should significantly reduce the previously cited maintenance and logistic burdens.

PM/FD/FL DESCRIPTION

PM/FD/FL is a sophisticated computer controlled three-function type of Built In Test (BIT). It consists of methods that ensure system integrity and consistency and eliminate the need for the operator to make value judgments. System integrity is determined by the design of the PM/FD/FL functions - not by operator motivation, training, or ability. PM/FD/FL must be incorporated into equipment and systems where construction complexity, environment, or required response times cause the unaided determination of system integrity or the identification and isolation of faults to be beyond the capability of available personnel.

In practice, the three PM/FD/FL functions are often independent functions, each with a level of sophistication commensurate with the needs of the application. They are also often misunderstood. The following explanatory definitions are intended to provide a better understanding of each of the PM/FD/FL functions.

PERFORMANCE MONITORING (PM) is the function that determines the integrity of an equipment or system. It accomplishes this by injecting known and quantified inputs into the equipment or system, observing responses for expected performance, and reporting deviations from expected performance. The injection of test signals is usually planned so that they do not interfere with the operation of the equipment or system. The PM function may also detect faults, but unless the application allows the combination of PM and FD functions, fault detection by the PM function is a secondary requirement. PM is necessary because deviations from the tolerances of individual items within a system could be acceptable, but can combine to produce unacceptable degradation of the total system; and because trends and/or tendencies to eventual failure would most likely be detected through PM.

FAULT DETECTION (FD) is the function that detects and reports faults. It is usually based on the monitoring of normally occurring outputs at selected test points for expected observations. During normal operation of the equipment or system, there is no test signal injection. FD may, in some cases, be combined with PM, but FD cannot be used to perform PM. The absence of faults is not prima facie evidence that the system is working correctly. FD requirements are to detect all measurable faults, including those that do not cause immediate equipment or system failure but may ultimately result in system failure. These are defined as eminent failures. The failure definitions in the equipment/system specification should define the faults that cause immediate system failure and those that could cause eminent failures.

FAULT LOCALIZATION (FL) is the function that isolates faults found by the PM and FD functions down to a group of modules that is small enough for effective maintenance at the organizational level. It usually employs more comprehensive tests than either PM or FD. FL tests are often invasive and require that the equipment or system be taken off line for fault localization and repair. In high reliability systems, the adverse effect of off-line localization and repair is minimized by the use of (parallel) redundant equipment.

PM/FD/FL DESIGN CONSIDERATIONS

Ideally, PM/FD/FL should be run noninvasively. As a minimum it should be run on algorithms that are predetermined not by an operator, but rather by priority needs of each of the subsystems that comprise the total system. The on-line portions of PM/FD/FL are operated at a cyclic rate that is constrained by: computer and system architecture; logic design; the resident executive operating system; software language; and software speed requirements.

System design should allow for stopping system operations for an advanced PM/FD/FL check, but the more manual the method, the less effective the design philosophy of the PM/FD/FL functions. The major PM/FD/FL design criteria is allowance for consistency in determination of system integrity without intervention of the operator. Consistency and repeatability should be given high priority during design of the PM/FD/FL functions.

Performance monitoring is a macro measurement of the health of the system. It determines system integrity by treating the system as a "black box" that responds to predetermined inputs by producing expected outputs. PM should not be under operator control; be run interactively as an interactive process; be running at all times when the system is powered up and initialized. PM should clearly inform the operator of system status by keying status displays such as: "All monitored subsystems and data in the PM functions are satisfactory at this time." As a by product of performance monitoring, the PM function may also detect and localize faults to some extent. The extent of fault detection and localization depends on the design of the PM function. Problems detected by the PM design are called faults. They may not be as clearly defined as the FD type fault detection system and could cause confusion due to the differences in terminology with the faults detected by the FD system.

The major purpose of the FD system is to detect faults. It usually accomplishes this by using what is known as the "white box" method. This method bases fault detection on testing for selected criteria that are unique to specific modules. To the greatest extent possible, FD should be performed automatically on-line. It is then free of operator ability and its integrity is determined by the design philosophy. In the on-line mode, FD provides limited support of fault isolation. In some systems, FD tests may also be performed on a scheduled off-line basis to obtain greater fault detection sensitivity.

Fault localization should be designed so that fault isolation at the organizational level can be quickly performed by maintenance personnel with minimal skills, without the use of external equipment, and with minimal requirements for maintenance assist modules.

A fault is present whenever anything doesn't work as expected. It may or may not be detectable by the FD function, and it may or may not result in system failure. The objective is to design the FD function for the highest possible coverage of fault detection, and to clearly distinguish between faults that cause system failure and those that do not.

Designers of PM/FD functions may find the Major, Minor, and Recoverable classification of faults to be useful. Major faults result in total loss of system function, which cannot be recovered without off-line maintenance action. Minor failures result in performance degradation, but not below allowable performance thresholds. Recoverable failures are those which allow the system to function as intended without significant interruption of performance after some minor action, such as reconfiguration or reinitialization, is taken.

PM/FD/FL TAILORING

The previous discussion pertains to a large, complex, and mission essential system with low tolerance for interruption of operation and with high capability displays that are manned continuously. The operator knows system status through observation of PM messages, and, when either an unfavorable PM message or a fault message is displayed, he initiates maintenance actions and guides those actions through observation and reporting of the FL messages that are given. In such a system, the PM, FD, and FL functions are almost equally important. There are several other types of systems where this is not so. Two types of systems with different PM/FD/FL requirements are discussed in the following paragraphs. These examples show how important it is to tailor the PM/FD/FL design to the requirements.

A missile may have a PM function used for preventive maintenance and pre-firing checks, but no FD or FL functions that operate at the organizational level. When PM indicates a problem, the equipment is usually removed and returned to the depot for repairs. In addition operation of PM requires a test set that is external to the weapon.

An unmanned mission-essential system may have PM, FD, and FL functions, but then PM is of much greater importance than FD or FL because there is no operator to note changes in performance through visual indications and the method of diagnostics differs from that of a manned system. In this case, automatic notification of changes in system integrity is of primary importance. Such systems usually have very high reliability to minimize the probability of failure during a mission. However the PM and FD functions must be capable of identifying or localizing faults sufficiently to allow repairs when the system is retrieved.

PERFORMANCE MONITORING, FAULT DETECTION, FAULT LOCALIZATION DESIGN GUIDANCE

THE PM/FD/FL PROGRAM

SECTION II: REQUIREMENTS

1.0 SCOPE

1.1 Purpose. This report contains uniform procedures and methods for developing and implementing a program for the design, assessment, and validation of Performance Monitoring, Fault Detection, and Fault Localization (PM/FD/FL) functions within the constraints of system development programs.

1.2 Application. The procedures and methods of this report are applicable to the development of PM/FD/FL functions for Department of Defense electronic systems based on embedded computers and processors. The methods and procedures of this document are to be applied as applicable during the Conceptual, Demonstration and Validation, Full Scale Engineering Development, and Production phases of the system acquisition process.

1.3 Tailoring. Tasks described in this report are to be tailored as appropriate to program phases and the particular needs of the system or equipment acquisition program.

2.0 RELATED DOCUMENTS

This report is intended to stand alone, but it is consistent with the methods, procedures, and definitions of the documents referenced below.

Military Standards

DOD-STD-2167	Defense System Software Development
DOD-STD-2168	Defense System Software Quality Program
MIL-STD-470	Maintainability Program for Systems and Equipment
MIL-STD-471	Maintainability Verification/ Demonstration/ Evaluation
MIL-STD-721	Definition of Effectiveness Terms for Reliability and Maintainability
MIL-STD-785	Reliability Program for Systems and Equipment, Development and Production.
MIL-STD-1309	Definition of Terms for Test, Measurement and Diagnostic Equipment
MIL-STD-1388-1	Logistic Support Analysis
MIL-STD-2165	Testability Program for Electronic Systems and Equipments.

3.0 DEFINITIONS AND ACRONYMS

3.1 Definitions. Terms used in this report are defined in Appendix B. They are consistent with the definitions in 2.0 Related Documents.

3.2 Acronyms. The acronyms used in this document are defined as indicated in this paragraph.

CDR	Critical Design Review
CDRL	Contract Data Requirements List
D&V	Demonstration and Validation
DID	Data Item Description
EDM	Engineering Development Model
FD	Fault Detection
FIG	Fault Isolation Group
FL	Fault Localization
FSED	Full Scale Engineering Development
IPR	In-Process Review
IV&V	Independent Verification and Validation
LRU	Lowest Replaceable Unit
PDR	Preliminary Design Review
PIDS	Prime Item Development Specification
PM	Performance Monitoring
PM/FD/FL	Performance Monitoring, Fault Detection, and Fault Localization
SOW	Statement of Work

4.0 GENERAL REQUIREMENTS

4.1 Scope of PM/FD/FL Program. The program plan of this report identifies inter-disciplinary efforts required to develop PM/FD/FL functions that meet mission and system requirements. The scope of these efforts includes:

1. Support of and integration with maintainability design, including requirements for performance monitoring, fault detection, and fault localization at the organizational level;
2. Support of integrated logistic support requirements, including minimization of requirements for spares, maintenance assist modules, and test equipment;
3. Support of and integration with design engineering requirements, including the hierarchical development of PM/FD/FL requirements from the system to the piece part;
4. Assurance of a balance between determination of system integrity and maintenance assistance that meets the needs of the mission and equipment application.

4.2 PM/FD/FL Requirements. A combined PM, FD, and FL program shall be established which accomplishes the following general requirements:

1. Preparation of a PM/FD/FL program plan;
2. Establishment of PM/FD/FL requirements that are consistent with mission requirements and equipment application;
3. Coordination of PM, FD, and FL software and hardware design with other software and hardware design efforts to ensure integration of PM, FD, FL with operational hardware and software;
4. Quantitative and qualitative evaluation of the extent to which the PM, FD, and FL designs meet requirements;
5. Inclusion of PM, FD, FL in design and program review processes.

4.3 Application of Requirements. Detailed requirements described in this document are to be selectively applied and are intended to be tailored, as required, and as appropriate to particular system and equipment acquisition programs. Appendix A provides rationale and guidance for the selection and tailoring of PM, FD, and FL tasks.

5.0 DETAILED REQUIREMENTS

5.1 Program Elements. The major elements of a full fledged PM/FD/FL program and the acquisition phase in which each element is operative are identified in Table 1. Numbered elements are contractor tasks.

TABLE 1
PM/FD/FL PROGRAM ELEMENTS

ELEMENT	PROGRAM ELEMENT ELEMENT NAME	PROGRAM PHASE		
		D&V	FSED	PROD
-	Requirements Determination	yes	yes	no
100	Program Surveillance and Control			
101	Program plan	yes	yes	yes
102	Monitor/control subcontractors/vendors	no	yes	yes
103	Program reviews	yes	yes	no
104	Configuration management	no	yes	yes
200	Design and Evaluation			
201	Modeling	yes	yes	no
202	Allocation	yes	yes	no
203	Prediction	no	yes	no
204	Fault tree analysis	no	yes	no
205	Fault identification analysis	no	yes	no
206	Fault impact analysis	no	yes	no
207	Transient smoothing analysis	no	yes	no
300	Development and Production Testing			
301	Function certification	no	yes	no
302	Independent verification & validation	no	yes	no
304	Factory Acceptance Test (FAT)	no	no	yes
-	Fleet Assessment	no	yes	yes

5.1.1 Requirements Determination. The Government program manager will develop the PM, FD, and FL requirements and determine the emphasis on each of them during Demonstration and Validation (D&V). Quantitative requirements will be determined through mission and trade-off analyses. These requirements will be refined during the early stages of Full Scale Engineering Development (FSED).

5.1.2 Field Assessment. The Engineering Development Models (EDM) and the first few Production systems will be monitored by the Government program manager for signs of problems or weaknesses in the PM, FD, and FL functions. This monitoring will be a subset of the monitoring that will be used to assess the system for signs of reliability, maintainability, and logistics problems.

5.2 Task Descriptions. The program plan portion of this report contains a comprehensive set of PM/FD/FL task descriptions. These are intended for tailored incorporation in each Statement of Work (SOW) of acquisition contracts for Department of Defense (DOD) electronic systems and equipment. In this report, the acronyms PM, FD, and FL rather than PM/FD/FL are used whenever it is necessary to emphasize the fact that the three functions can receive different degrees of attention depending on mission requirements and equipment application. The PM/FD/FL tasks intended for incorporation in appropriate SOWs are identified in Table 2.

TABLE 2
PM/FD/FL TASK REQUIREMENTS (CONTRACTOR)

NUMBER	TASK TASK NAME	FUNCTION APPLICATION		
		PM	FD	FL
100	Program Surveillance and Control			
101	Program plan	yes	yes	yes
102	Monitor/control subcontractors/vendors	yes	yes	yes
103	Program reviews	yes	yes	yes
104	Configuration management	yes	yes	yes
200	Design and Evaluation			
201	Modeling	yes	yes	yes
202	Allocation	yes	yes	yes
203	Prediction	yes	yes	yes
204	Fault tree analysis	yes	yes	no
205	Fault identification analysis	no	yes	yes
206	Fault impact analysis	yes	yes	r.o
207	Transient smoothing analysis	no	yes	no
300	Development and Production Testing			
301	Function certification	yes	yes	yes
302	Independent verification & validation	yes	yes	yes
304	Factory Acceptance Test (FAT)	no	no	yes

5.2.1 Structuring the Program. Development of the PM/FD/FL functions is a subset of the system development program. The resulting commonality of development methodology permits several PM/FD/FL tasks to be integrated into system tasks, but care must be taken to ensure that visibility into PM/FD/FL remains after integration of tasks. There must be sufficient visibility into PM/FD/FL development to ensure that its development occurs simultaneously with, and retains the same momentum as, the development of other functions. In addition, visibility must be sufficient to ensure early identification of problems and confidence in achievement of requirements. The PM/FD/FL program must be structured to ensure this visibility while optimizing the use of development resources and eliminating duplication of effort.

The PM, FD, and FL programs must also be structured to consider the impact of policy documents such as DOD 4245.7-M (Transition from Development to Production - Solving the Risk Equation). Such documents will be identified in the Applicable Documents section of the contract Statement of Work.

Tasks and program elements will be selected and tailored to match the emphasis placed on each of the PM/FD/FL functions and to match the acquisition phase that is being addressed. For example, the greatest emphasis may be placed on PM (system integrity) in the case of a mission critical unmanned system, while FL may receive the greatest emphasis in the case of a mission critical system that is continuously manned.

5.2.2 Program Interfaces. The PM, FD, and FL program interfaces with: system development, design, test, and demonstration; Configuration Management; Reliability; Maintainability; Integrated Logistics Support; Safety; and Human Factors. During development and assessment, essential data is sent to, and received from, these and other disciplines through the interfaces. It is important that these interfaces be recognized by those managing the PM, FD, and FL programs, and that these communications be kept open.

6.0 DATA REQUIREMENTS

6.1 Deliverable Data. When this report is used in an acquisition, the data identified in this paragraph shall be deliverable only when specified on the DD Form 1423 Contract Data Requirement List (CDRL). When the DD Form 1423 is not used and the Defense Acquisition Regulation 7-104.9(n) is cited, the data identified below shall be delivered in accordance with the requirements specified in the contract or purchase order. Deliverable data associated with the requirements of this document are identified in the Data Item Descriptions (DID) of Table 3. Data item descriptions for related requirements are also included.

6.2 Document Samples.

Samples of contract SOWs and CDRL items are provided in Appendices C and D, respectively.

TABLE 3
DATA REQUIREMENTS

TASK	DATA REQUIREMENT	APPLICABLE DATA ITEM DESCRIPTION (DID)
100	PROGRAM SURVEILLANCE AND CONTROL	
101	Program plans	DI-ATTS-80005
103	Design reviews	DI-E 5423
104	Configuration management	DI-E-3108
200	DESIGN AND EVALUATION	
201	Modeling	DI-MNTY-80825
202	Allocation	DI-MNTY-80826
203	Prediction	DI-MNTY-80827
204	Fault tree analysis	DI-MISC-80048
205	Fault identification analysis	DI-MISC-80048
206	Fault impact analysis	DI-MISC-80048
207	Transient smoothing analysis	DI-MISC-80048
300	DEVELOPMENT AND PRODUCTION TESTING	
301	Function certification	UDI-T-23732B
302	Independent verification & validation	UDI-T-23732B
304	Factory Acceptance Test (FAT)	UDI-T-23732B

Additional Data Item Descriptions:

DATA COLLECTION	DI-MNTY-80824
TESTABILITY PROGRAM PLAN	DI-T-7198
TESTABILITY ANALYSIS REPORT	DI-T-7199

PERFORMANCE MONITORING, FAULT DETECTION, FAULT LOCALIZATION DESIGN GUIDANCE

THE PM/FD/FL PROGRAM

SECTION III - TASK DESCRIPTIONS

INTRODUCTION

In this section, the usual PM/FD/FL acronym has been changed to PM, FD, and FL to emphasize the semi-independence of these functions. This semi-independence is needed because the emphasis placed on each of these functions will vary with the application.

To provide complete visibility into the PM, FD, and FL development process, each task of this section is fully described. In practice, several of the tasks may be combined with similar tasks of other disciplines provided that visibility into the PM, FD, and FL development process is not lost. PM, FD, and FL candidates for combination with tasks of other disciplines are:

- o Program Plan
- o Control of Subcontractors and Suppliers
- o Design Reviews
- o Configuration Management
- o Independent Verification and Validation
- o Function Certification

All other tasks of this section are unique to PM, FD, and/or FL. The contractor shall provide justification, and receive approval of the DOD Program Manager, before combining tasks.

The major task groupings of this section are:

- o Program surveillance and control;
- o Design and evaluation;
- o Development and production testing.

All of the tasks of this section are to be performed by the contractor. The DOD program manager has review and approval authority over the work performed under these tasks.

It is important that the contractual requirements of each task be tailored to system requirements and fully described in the SOW of the contract. The DIDs used to get deliverable documents are adaptations of existing DIDs that do not fully describe PM/FD/FL requirements. New DIDs, specifically designed for PM/FD/FL reporting, will be required in the future.

TASK 101 PM, FD, AND FL PROGRAM PLAN

101.1 Overview. The PM, FD, and FL Program Plan (Plan) shall be designed as a basic tool to assist the contractor in implementing an effective PM, FD, and FL development program. The Government Program Manager will use the Plan to (1) evaluate the contractor's approach to, and his execution of, PM, FD, and FL tasks, (2) evaluate the adequacy of his procedures for planning, implementing, and controlling the PM, FD, and FL tasks, and (3) evaluate the ability of his organizational structure to focus on PM, FD, and FL activities/problems.

101.2 Purpose. The purpose of Task 101 is to develop a PM, FD, and FL Program Plan that identifies and integrates all program tasks necessary to accomplish the requirements of the Prime Item Development Specification (PIDS) and the Statement of Work (SOW).

101.3 Task Description. A PM, FD, and FL Program Plan shall be prepared to provide, as a minimum, the following:

1. A description of how the program will be conducted to meet the requirements of the PIDS and the SOW.
2. A description of how PM, FD, and FL designs interface with total system design.
3. A detailed description of how each specific PM, FD, and FL requirement will be performed or complied with.
4. The procedures to evaluate the status and control of each task, and identification of the organizational unit with the authority and responsibility for executing each task.
5. Description of the management structure, including interrelationship between line, service, staff, and policy organizations.
6. Identification of key personnel for managing the PM, FD, and FL program and the level of authority for problem resolution.
7. The method by which the PM, FD, and FL requirements are disseminated to designers and associated personnel, and how design interfaces are accomplished.
8. A schedule with estimated start and completion points for each PM, FD, and FL program activity or task.

9. The designation of PM, FD, and FL milestones, including design, design review (PDR, CDR, IPR), and test.
10. The identification of known PM, FD, and FL problems to be solved, an assessment of the impact of these problems on meeting specified requirements, and the proposed solutions or proposed plan to solve them.
11. The procedure or methods for recording the status of actions taken to resolve problems.

When approved by the Government Program Manager, the PM, FD, and FL Program Plan shall become a basis for evaluation of contractual compliance.

TASK 102 MONITOR/CONTROL OF SUBCONTRACTORS AND SUPPLIERS

102.1 Overview. Monitoring and control of subcontractors and suppliers provides visibility into subcontractor/supplier achievement of flowed down PM, FD, and FL requirements and the control needed to ensure achievement of requirements. Monitoring and control also ensures that subcontractor/supplier PM, FD, and FL efforts remain consistent with system PM, FD, and FL design and requirements.

102.2 Purpose. The purpose of Task 102 is to provide the prime contractor with appropriate surveillance and management control of subcontractor and supplier PM, FD, and FL efforts so that timely management action can be taken as the need arises.

102.3 Task Description. The contractor shall insure that system elements obtained from subcontractors and suppliers will meet the flowed down PM, FD, and FL requirements. All subcontracts shall include provisions for review and evaluation of the subcontractors' PM, FD, and FL efforts by the prime contractor, and by the procuring activity at its discretion. The contractor shall, as appropriate:

1. Incorporate quantitative PM, FD, and FL requirements in subcontracted equipment specifications.
2. Assure that subcontractors have a PM, FD, and FL program that is consistent with the system PM, FD, and FL program and includes provisions to review and evaluate their suppliers' FD and FL efforts.
3. Attend and participate in subcontractors' design reviews.
4. Review subcontractors' PM, FD, and FL analyses for accuracy and correctness of approach.
5. Review subcontractors' test plans, procedures, and reports for accuracy and correctness of approach.

TASK 103 PM, FD, AND FL DESIGN REVIEWS

103.1 Overview. Design reviews shall be held to determine whether or not the projected PM, FD, and FL designs will meet the requirements of the specifications and to assess the suitability of hardware and software design. At the onset, reviews should be held frequently to ensure that the contractor does not proceed with unsuitable designs. The reviews should also confirm that the contractor is meeting the intent as well as the wording of the specification. It is not necessary that the PM, FD, and FL be separate from other reviews, providing that PM, FD, and FL receive the visibility needed to ensure that the contractor is performing and adhering to specifications and contract requirements.

103.2 Purpose. The purpose of Task 103 is to establish a requirement for the contractor to conduct formal and informal PM, FD, and FL design reviews.

103.3 Task Description. PM, FD, and FL formal design reviews shall be conducted in accordance with the requirements of MIL-STD-1521B or a schedule approved by the Government. Informal in-process PM, FD, and FL reviews shall be conducted at least quarterly with a mutually agreed upon schedule by the Government and Contractor until formal Critical Design Reviews are initiated. In addition to the design review requirements of MIL-STD-1521B, the following design reviews shall include review of the PM, FD, and FL items indicated below.

1. Preliminary Design Review (PDR):
 - a. Updated PM, FD, and FL program status including:
 - 1) PM, FD, FL modeling;
 - 2) PM, FD, FL allocation;
 - 3) PM, FD, FL predictions;
 - 4) PM, FD, FL specification compliance/traceability;
 - 5) Design guideline criteria.
 - b. Problems affecting PM, FD, and/or FL.
 - c. PM, FD, and/or FL critical items.
2. Critical Design Review (CDR):
 - a. PM, FD, and FL compliance with specifications.
 - b. PM, FD, and FL predictions and analyses.
 - c. PM, FD, and FL critical items.
 - d. Problems affecting PM, FD, and/or FL.
 - e. Identification of functions requiring high reliability or a large number of lines of code software/firmware.
 - f. Analysis results.

3. In-Process PM, FD, and FL Reviews (IPR):
 - a. Consideration of those PM, FD, and FL items identified in subparagraph 1 and 2.
 - b. Results of PM, FD, and FL tests and analyses.
 - c. Test schedule: start and completion dates.
 - d. PM, FD, and/or FL parts, design, reliability, and schedule problems.
 - e. Status of PM, FD, and/or FL action items.
 - f. Contractor's assessment of PM, FD, and FL design effectiveness.
 - g. Other topics and issues as needed.
 - h. Results of applicable PM, FD, and FL testing.
4. Test Readiness Review:
 - a. PM, FD, and FL analyses status and PM, FD, and FL predictions.
 - b. Test schedule.
 - c. Test profile.
 - d. Test plan including failure definitions.
 - e. Test report.
5. Production Readiness Review: Results of applicable PM, FD, and FL testing.

TASK 104 PM, FD, AND FL CONFIGURATION MANAGEMENT

104.1 Overview. The contractor shall develop and implement Configuration Management procedures which provide technical and administrative direction and surveillance to:

1. Identify and document the functional and physical characteristics of each hardware and software/firmware configuration items of the PM, FD, and FL functions.
2. Control changes to these characteristics.
3. Record and report the processing of changes and the status of implementation. The contractor shall perform PM, FD, and FL CM within the framework of the system CM.

104.2 Purpose. The purpose of this task is to provide the contractor and the Government Program Manager with the information needed to identify the initial hardware software/firmware configuration of the PM, FD, and FL functions and to track the status and effects of change-proposal and change-implementation actions.

104.3 Task Description. The contractor shall apply CM to the hardware, software, and firmware of the PM, FD, and FL function within the framework of the hardware and software CM of the system. System and function CM shall be in accordance with MIL-STD-483, MIL-STD-490 and DOD-STD-2167 as tailored by the contract and government requirements document. Data pertaining to the PM, FD, and FL shall include, but not be limited to:

1. Requirements as provided to subcontractors.
2. Subcontractors response and interpretation of requirements.
3. Test procedures by contractor and subcontractors.
4. Any qualification tests, results, conclusions, and/or observations.
5. Changes as provided by the program office, as initiated by the contractor, as required by the results from new data as required for any other purposes.
6. All data item requirements.
7. All data necessary for life cycle support and test certification.
8. Design drawings, source code, program language(s), and other documentation to provide the capability for independent certification, duplication of the system, subsystem, elements, firmware/software, and hardware.

TASK 201 PM, FD, AND FL MODELING

201.1 Overview. Both quantitative and qualitative analyses are useful in determining where PM, FD, and FL resources should be applied. The analyses identify design and quality improvements that must be made if requirements are to be met. In particular, the analyses are efficient work direction tools because they can confirm system adequacy or identify the need for design change, provided they are accomplished in conjunction with, or reviewed by, other disciplines. Models provide the basis for assessment of PM, FD, and FL performance, effectiveness, and system impact. They are used in the allocation of system level requirements to specific hardware and software functions, and in the prediction of performance parameters. The PM, FD, and FL models are derived from the system reliability and maintainability models.

201.2 Purpose. The purpose of Task 201 is to develop PM, FD, and FL models for making numerical allocations and estimates to evaluate system/subsystem/equipment PM, FD, and FL monitoring effectiveness.

201.3 Task Description. PM, FD, and FL mathematical models based on system/subsystem/equipment functions shall be developed and maintained. As the design evolves, PM, FD, and FL block diagram (Fault Isolation Groupings) (FIGs) with associated allocations and predictions for all elements in the FIG shall be created. The PM, FD, and FL block diagrams shall be keyed and traceable to the functional block diagram, schematics, drawings, and specifications.

The model outputs shall be expressed in terms of PM, FD, and FL requirements. As changes occur, the model shall be updated to include hardware and/or software/firmware design changes. The PM, FD, and FL models shall be updated with information resulting from relevant tests and changes in item configuration.

TASK 202 PM, FD, AND FL ALLOCATION

202.1 Overview. System PM, FD, and FL requirements evolve in a number of ways from informed judgments to analyses based on empirical data. The requirements are designed to minimize the total cost of developing, procuring, and operating the system during its life cycle. The integrity of the system is maintained by adequate top-down design that ensures the ability of the system to meet specified requirements. Allocated requirements must be iteratively refined before resources can be specifically designated to meet the requirements.

202.2 Purpose. The purpose of Task 202 is to ensure that, once quantitative system requirements have been determined, they are allocated or apportioned to lower levels.

202.3 Task Description. Both the mission and mission integrity requirements shall be allocated to the level specified and shall be used to establish the baseline requirements for equipment and software/firmware designer. Requirements consistent with the top level allocations shall be imposed on all subcontractors and suppliers. The allocated values shall be included in appropriate sections of any procurement specifications, critical item specifications, and contract end item specifications to subcontractors/suppliers.

All allocated PM, FD, and FL values established by the contractor and included in subcontract item specifications shall be consistent with the mathematical model required in Task 201.

TASK 203 PM, FD, AND FL PREDICTIONS

203.1 Overview. Allocations are determined from the system PM, FD, and FL requirements to provide lower level requirements which are levied on the designers and software/firmware engineers. As design work progresses, predictions based on previously generated data and assessments based on program test data are used to determine whether the allocated requirements can or will be met.

Predictions combine lower level PM, FD, and FL data to indicate equipment PM, FD, and FL performance at successively higher levels, from subassemblies through subsystem to system. Predictions falling short of requirements at any level signal the need for management and technical attention.

203.2 Purpose. The purpose of Task 203 is to estimate PM, FD, and FL capabilities of the system, subsystem, equipment, hardware, and software/firmware and to determine whether or not the PM, FD, and FL requirements can be achieved with the proposed design.

203.3 Task Description. PM, FD, and FL predictions shall be made for the system, subsystem, equipment, hardware, and software/firmware. PM predictions shall include the probability of: functional failure; not diagnosing a performance fault, and incorrectly diagnosing a performance fault. FD parameters of interest are the probability of: not diagnosing a fault; and incorrectly diagnosing a fault. FL parameters of interest are the probability of: not localizing a fault; isolating a fault to the incorrect Fault Isolation Group; and localizing a fault to within the correct fault group. Predictions shall be made (1) to show the ability of the PM, FD, and FL function to assess system and subsystem integrity, (2) to provide a basis for life-cycle and logistic support analyses, and (3) to provide a basis for estimating system availability.

The predictions shall use the associated PM, FD, and FL block diagrams of Task 201 and PM, FD, and FL coverage data and shall be approved by the Government. Items and equipment shall not be excluded from the prediction.

TASK 204 PERFORMANCE MONITORING/FAULT DETECTION FAULT TREE

204.1 Overview. The PM/FD Fault tree is used as a basic tool by the contractor, the government program office, and the independent verification and validation (IV&V) groups to determine the path of initial fault observation to the final display.

204.2 Purpose. The specific purpose of the PM/FD fault tree is to assist in designing, testing, and implementing an effective PM/FD. The PM/FD fault tree shall be used to evaluate the contractor's approach to, and confirmation of, adherence to PIDS requirements.

204.3 Task Description. The fault tree shall identify each fault test point and its pass/fail levels. Each functional failure shall be labeled and described. The description shall include:

1. All test points that are used to determine if a functional failure exists. Where a votive or count determination (e.g., 3 out of 5) exists, descriptions shall be supplied.
2. Identification of test points that are common to any other PM/FD/FL subprograms or tests.
3. The contractor's verification that determinations of PM/FD fault indications are direct, not made by inference or other indirect observations.
4. Proof that software/firmware programs that are used for determination are labeled and referenced to the configuration item where they are located.

TASK 205 FD AND FL FAULT IDENTIFICATION ANALYSIS

205.1 Overview. Faults that are detected must also be correctly identified. In order to perform repair actions, much detail about each fault is required. The particular off-line tests using the FL function which identify the correct Fault Isolation Group (FIG) and possibly the failing Lowest Replacement Unit (LRU) often require that more than one FL test be performed. For this reason, all monitored test points that provide fault information to the central PM/FD/FL function must be correctly designed. The information from these test points must be recorded and assimilated into proper groupings, which identify the suitable FL test to be performed.

Many faults cause domino effects where the occurrence of one fault causes additional fault indications. In order to provide effective repair, in minimum time, and also to evaluate the impact on the system caused by the root fault, it is necessary that the root fault be determined and found. The design of the fault localization subsystem must be of sufficient complexity to isolate the root fault despite the occurrence of multiple faults and other ambiguities.

205.2 Purpose. The purpose of Task 205 is to verify that proper fault identification, display, and maintenance action codes will be available to maintenance personnel. Verification shall also demonstrate that the identity of any faults detected will be prioritized so that maintenance personnel will perform tests for the more likely fault first. Verification shall show that the correct information specified in the PIDS for each detected fault is correctly provided to and displayed on the maintenance panel.

205.3 Task Description. A fault identification plan for FD and FL shall be developed and include, but not be limited to:

1. A description of how fault identification is handled by the system.
2. A description of how the fault identification design meets PIDS requirements.
3. A test plan and procedure for proper fault identification.
4. A worst-case series of tests to show that the most likely fault is displayed first.
5. Test cases intended to be ambiguous with respect to which fault initiated the problem.

6. Stress tests for proper fault identification under actual operating conditions.
7. A listing of the test panel indications for all above tests. Documentation of all fault localization results shall be included in the task.

Note that the fault identification test does not apply to PM.

TASK 206 FAULT IMPACT ANALYSIS (PM AND FD)

206.1 Overview. Not all faults have the same effect on system integrity, effectiveness, or operational availability. Some faults mask others that may have more of an impact on system integrity. Similarly, certain portions of systems have redundancies, either natural or planned. In the case of faults in redundant portions, it may be possible to schedule maintenance for some planned time. The faults, then, are not critical to system integrity or operations, provided they are recorded and repaired at the next repair cycle time. When a multitude of faults occur, there are often one or two major faults that have had a ripple effect and cause other faults to be displayed. The ripple impact is potentially dangerous because the impact on system operation will not be easily determined and the parent fault(s) of the problem may not be identified. By assigning levels of impact to each fault, there is a better probability of correctly assessing the fault impact, determining system impact, and looking for the most damaging fault first.

In effect, giving a level of impact to each fault allows for more correct diagnosis of the actual cause of failures. For example, if a power supply were to be in fault, most of the items that had test points for the performance monitoring subsystem would give indications of failure. For this reason, given the multitude of possible faults occurring or seeming to occur all at once, it is necessary to determine the impact of every test point used for the performance monitoring subsystem. The standard procedure is to give each fault an impact level (sometimes called a priority level).

206.2 Purpose. The PM purpose of Task 206 is to test the ability of the performance monitoring subsystem to correctly determine the impact of faults that it has detected with respect to the integrity and effectiveness of the major system. The FD purpose of Task 206 is to test the ability of the fault detection subsystem to correctly identify faults it has detected and to correctly determine the impact of those faults with respect to the integrity and effectiveness of the major system. Additionally, this task is to demonstrate that faults do not mask each other when they occur at the same time. This task is also to demonstrate that the fault determination will allow for maintenance actions in the required time and to the proper FIG.

206.3 Task Description. A PM/FD plan for fault impact shall be developed and include, but not be limited to:

1. A description of how fault impact is handled by the system.
2. A description of how the PM meets the PIDS requirements.
3. A test plan and procedure for testing fault impact.
4. A worst-case series of tests and their evaluations regarding which fault created the problem.
5. Test cases intended to be ambiguous with respect to which fault initiated the problem.
6. Stress test cases under actual operating conditions.
7. A listing of test panel indicators for all tests.

Documentation of all fault impact test results shall be included in this task.

TASK 207 FAULT DETECTION FUNCTION TRANSIENT SMOOTHING (FD ONLY)

207.1 Overview. Electronic systems, especially those that have long distances between units, are susceptible to all kinds of interference, including DC offsets, ground loops, EMI, and noise bursts and pulses caused by other electronic devices. The devices themselves may also cause transients when certain combinations of operations are performed. Therefore, a simple pass/fail test at any test point may show indication of a fault when, in fact, there is none. Similarly, a fault finding may be lost or erroneously modified during transmission from one system component to another. Transient smoothing is, therefore, required to reduce the number of false fault indications. It is also imperative that certain test points which are critical to system integrity have their responses quickly read. All test points should be able to report within given latency times even if anomalies exist somewhere in the subsystem.

207.2 Purpose. The purpose of Task 207 is to ensure the ability of the FD subsystem to:

1. Report all faults within the specified latency time, regardless of anomalies, either at the test point or during transmission from one point to another.
2. Report the condition of any test point that has become inoperative or incommunicative.
3. Not report non-recurring faults, glitches, or transients.

207.3 Task Description. A Fault Detection Transient Smoothing Plan for design, test, certification, and verification shall be developed and implemented. The plan shall include, but not be limited to:

1. A description of how each fault is handled to avoid false alarms.
2. A description of verification/validation test plans for transient smoothing.
3. A description of verification of tests to be performed under worst-case actual operating conditions or equivalent.
4. A description of the verification test that ensures the reporting of faults within the time specified in the PIDS.

A report on the implementation of this plan, including test findings, shall be included in all design reviews.

TASK 301 FUNCTION DESIGN QUALIFICATION (PM, FD, AND FL)

301.1 Overview. It is vital that designs be tested not only to see if the designs themselves are functional and fault free, but also that the designs meet both the intent as well as the 'letter' of the specification. Verification of design to specification should be accomplished at all levels of development. When it appears to have been completed, retesting and reverification should occur, using the original design teams, contractor quality assurance personnel, independent test teams, and finally, representation of the Government program management.

301.2 Purpose. The purpose of this task is to verify and demonstrate that the designs for the PM, FD, and FL functions meet and show adherence to PIDS requirements in enough detail, quality, frequency, and number to provide a high level of confidence and achievement of these requirements.

301.3 Task Description. Task 301, function certification, is performance of a series of qualifying tests to determine adherence to the PIDS requirements. These tests shall be designed to answer, as a minimum, the following questions:

1. Did the (PM, FD, FL) function detect the fault?
2. Did the PM function indicate the proper operational status?
3. Did (PM, FD, FL) provide effective fault isolation information for corrective maintenance actions?
4. Did (PM, FD, FL) provide information for further tests that could affirm the problem?

5. Did the PM, FD function(s) provide information regarding the impact of the fault to the system?
6. What was the latency time between the occurrence of the fault and the final indication on the panel?
7. Was there any ambiguity surrounding the fault or the correction? (PM, FD, FL)
8. What are the total number of undetected faults in any given period? Why were they not detected?
9. Were there any unlocalized faults? Why were they not localized? (FL only)
10. What is the latency time from software glitch and/or hardware fault to automatic rebooting?

PM, FD, and FL design qualification is formal testing of entire systems to verify achievement of quantitative PM, FD, and FL requirements. It cannot be combined with the maintainability demonstration test, as is sometimes tried, because the requirements of the two tests differ considerably.

The maintainability demonstration shows that maintenance technicians equivalent to those expected to maintain the system can do so under in operation conditions that simulate anticipated conditions. During the demonstration, the technician tries to restore the system to operation after each of a series of simulated faults is inserted. The test is slow and expensive and is usually based on no more than 50 fault simulations.

The PM, FD, and FL demonstration verifies, with high confidence, that each of the quantitative PM, FD, and FL requirements is achieved. More than 200 simulations may be required to successfully verify achievement of some requirements with adequate coverage of all operational functions. These simulations may be performed rather quickly, since actual repair need not be accomplished, and the test can be performed in the laboratory by highly experienced engineers. The PM, FD, and FL demonstration should be performed before the maintainability demonstration.

TASK 302 INDEPENDENT VERIFICATION & VALIDATION

3.2.1 Overview. Independent PM, FD, and FL verification and validation performed by a scientific team not involved in the design, development, and tests ensures that the PM, FD, and FL designs meet the PIDS requirements. The independent IV&V team will ensure that the PM, FD, and FL subprogram will not fail and will perform to this intended capacity.

302.2 Purpose. The purpose of Task 302 is to independently determine that the PIDS and SOW requirements have been met.

302.3 Task Description. Procedures shall be independently established, maintained, and implemented, to be performed by test and analysis, to verify and validate the ability of the PM, FD, and FL subsystems to meet all of the PIDS and SOW requirements. Functional testing of the design shall employ methodologies of great stress and strain to the hardware and firmware/software.

The PM, FD, and FL subsystems shall be tested under worst-case actual operational conditions. The documentation produced by the IV&V team shall include, but not be limited to:

1. The test plan for the tests that will be conducted, including the operational conditions under which the tests will be performed.
2. The actual test procedures with dates, test engineer, location, and all other pertinent information.
3. Identification, description, listings, and source code for IV&V test programs.
4. Complete test reports, results, deficiencies, problems, and observations.

The final test of the IV&V test is to be a quantitative test of PM, FD, and FL capabilities. This test shall demonstrate that all quantitative requirements of the PIDS have been met at confidence levels that are acceptable to the Government program manager.

TASK 304 PRODUCTION TEST

304.1 Overview. Each Production system will be subjected to a Production Test (PT) to verify that the system meets all requirements. The PT will verify that each system meets the specified requirements, and that there has been no degradation of the processes used to produce the EDM systems. Verification of continued achievement of PM/FD/FL requirements will be made during this test. The PT will also be used to collect statistical data pertaining to the operation of the PM/FD/FL functions.

304.2 Purpose. The purpose of Task 304 is to ensure that the PIDS and SOW PM/FD/FL requirements are met in each delivered system.

304.3 Task Description. Production tests will be derived from the qualification tests. The PT will be used to determine whether or not each delivered system meets specified requirements. The PT will be primarily a qualitative test. It will not be sufficiently extensive to permit derivation of system parameters with a high level of confidence.

SECTION IV. CONCLUSIONS/SUMMARY

The continuing increase in complexity of military systems has imposed additional maintenance and logistic burdens on our operating forces. As these organizations experience a reduction of both manning and skill levels, the requirements for quick repair of equipment malfunctions has risen. Experience has indicated that when systems become fully operational, a number of problems are likely to occur and that these problems must be dealt with in an orderly, precise and cost effective manner. As a system matures, problems still exist and all but the simplest problems will pose insurmountable difficulties to the test and repair technician(s). Also, because major turnovers in experienced personnel is a fact that cannot be dismissed, automated performance monitoring, fault detection and fault localization for sustaining day-to-day support of a system must be accomplished by the user organization, namely our operating fleet. The report presented herein, therefore, presents a method of developing performance and maintenance aid design techniques that enables the system to localize faults to a manageable fault area. The technique shown provides a record of the design elements requisite to best design practices and provides a systematic approach to the PM/FD/FL process not previously provided in contract or SOW requirements. Incorporation of this document and/or portions thereof into system SOW documentation will allow relevant subject areas to be addressed and judgments of conformity to requirements can be more readily made by the reviewing agency.

The specification as described herein has been successfully applied to a Navy sponsored program. Elements, as developed, were collected and combined resulting in the subject document for the purpose of future application in programs requiring PM/FD/FL design/development.

APPENDIX A

PM, FD, AND FL PARAMETERS AND THEIR OPTIMIZATION

INTRODUCTION

Performance Monitoring (PM), Fault Detection (FD), and Fault Localization (FL) are often independent functions within a system or equipment, each with a level of sophistication commensurate with the needs of the application. PM, FD, and FL will be treated as separate functions in this discussion. The term "system" will be used throughout the discussion.

It is extremely important that PM, FD, and FL design be performed simultaneously with the design of the rest of the system. Add-on PM, FD, and FL functions will not perform in an optimal manner, and they will not be as cost effective as when designed as integral functions of the system.

Some quantitative parameters may need to be very high such as an 0.99 probability of success. In such cases, the quantitative requirement may become the value that can be demonstrated at a sufficiently high confidence level. While on this subject, the reader is cautioned that the MIL-STD-471A procedure for demonstrating testability attributes does not always result in satisfactory confidence levels.

PERFORMANCE MONITORING

PM is the function that determines the integrity of a system. It identifies unacceptable system degradation resulting from combinations of lower level deviations from tolerances that may be acceptable at the lower levels, and it may be designed to identify trends and tendencies to an eventual failure. The PM function accomplishes this through injection of known and quantified inputs into the system, observation of responses for expected performance, and reporting of deviations from expected performance. The injection of test signals should be planned so that these signals do not interfere with the normal operation of the equipment or system. The PM function may also detect faults, but unless the application allows the combination of PM/FD/FL functions, fault detection by the PM function is synergistic.

PM requirements that are to be specified and optimized for the specific application are the probability of:

- o A functional failure;
- o Not diagnosing a performance failure;
- o Incorrectly diagnosing a performance fault.

FAULT DETECTION

FD is the function that detects and reports faults. It is usually based on the monitoring of normally occurring outputs at selected test points for expected responses. It does not use test signal injection. FD may, in some cases, be combined with PM, but FD cannot be used to perform PM. The absence of faults is not prima facie evidence that the system is working correctly. FD should be designed to detect all measurable faults, including those that do not cause immediate equipment or system failure. The failure definitions in the equipment/system specification will define the faults that cause immediate system failure, and those that are latent failures. The Fault Detection Function usually uses the "white-box" methodology.

Quantitative requirements of FD that must be optimized for the application include the probability of:

- o Not diagnosing an existing fault;
- o Diagnosing a fault that does not exist;
- o Incorrectly diagnosing the location of a fault.

FAULT LOCALIZATION

FL is the function that isolates faults found by the PM and FD functions down to a group of modules that is small enough for effective maintenance. It usually employs more comprehensive tests than either PM or FL. FL tests are often invasive and require that the equipment or system be taken off-line for fault localization and repair. In high reliability systems, the effect of off-line localization and repair is minimized by the use of redundant (parallel) equipment.

Quantitative requirements of FL that must be optimized for the application include the probability of:

- o Not localizing the fault;
- o Localizing fault to an incorrect fault isolation group;
- o Localizing fault to within the correct fault group.

DESIGN OPTIMIZATION

Basic design and analysis efforts of PM/FD/FL may be based on tailored application of tasks 202 and 203 of MIL-STD-2165. In addition to these tasks, optimization of PM/FD/FL will require performance of the additional tasks described in this report.

The PM/FD/FL models and predictions will be used to optimize the locations of test points and plan for the demonstration and acceptance tests. They will be derived from the system reliability models and predictions, supplemented by information obtained from the system Failure Modes and Effects Analysis.

APPENDIX B
GLOSSARY OF TERMS

BACKGROUND

Those effects present in physical apparatus or surrounding environment which limit the measurement or observation of low level signals or phenomenon; commonly referred to as noise.

BLACK-BOX METHODOLOGY

The methodology which treats portions of electronic units as testable entities. Known and quantified inputs are injected into entities being tested and responses of the entities to those inputs are observed for purposes of determining the integrity of the entity under test.

ENHANCED PM/FD

Additional software and/or hardware incorporated to improve the probability of detecting faults.

FAILURE

A malfunction or combination of malfunctions that causes performance degradation below acceptable levels.

FAULT DETECTION

The PM/FD/FL function that detects and indicates faults and malfunctions.

FAULT IMPACT

A measurement of the effect of a fault on performance.

FAULT ISOLATION GROUP

That module or group of modules to which a fault is isolated.

FAULT LOCALIZATION

The PM/FD/FL function which further isolates faults found by the performance monitoring and/or fault detection function.

GLITCH

A transient event that results in the improper operation of any function, mode or submode and that cannot be related to a specific hardware fault.

IMMINENT FAILURE

Conditions that are likely to cause functional failures if a maintenance action is not performed.

LATENCY TIME

The length of time required to detect and identify a fault.

LOWEST REPLACEABLE UNIT

A unit which is designated by the maintenance plan to be removed upon failure from a larger entity in the latter's operational environment.

APPENDIX B (CONT'D)

MONITORED FAULT	Any fault which will cause measurable degradation in performance of any function within the system.
NON-INVASIVE	No adverse effect and/or non-allowable degradation on system performance.
PERFORMANCE MONITORING	The PM/FD/FL function that performs a macro view of a system, or part of a system, in order to determine the health of the portion under test. Usually employs some sort of end to end testing with a typical signal injection.
STRUCTURED METHODOLOGY	A method of design which divides functions into separate sub- functions that may be designed, tested, and measured separately.
SYSTEM INTEGRITY	That state of readiness where all system functions meet all requirements.
WHITE-BOX METHODOLOGY	The design methodology which states that by dividing a system into separate blocks, the individual blocks will have internal test points that will adequately provide a statement as to the blocks integrity.

APPENDIX C
STATEMENT OF WORK SAMPLES

STATEMENT OF WORK FOR PM/FD/FL

SAMPLE ONE

PERFORMANCE MONITORING, FAULT DETECTION, FAULT LOCALIZATION REQUIREMENTS

1.0 Performance Monitoring, Fault Detection, Fault Localization Program

The contractor shall develop and implement a PM/FD/FL program in accordance with the Statement of Work (SOW), the Prime Item Development Specification, and NUSC Technical Report 8315A as tailored by this Statement of Work.

1.1 Elements of the Program

As a minimum, the elements of the PM/FD/FL program shall be:

- a. Task 101 Program Plan (PM, FD, and FL)
- b. Task 102 Monitor/Control of Subcontractors/Vendors (PM, FD, FL)
- c. Task 103 Program Review (PM, FD, FL)
- d. Task 104 Configuration Management (PM, FD, FL)
- e. Task 201 Modeling (PM, FD, FL)
- f. Task 202 Allocations (PM, FD, FL)
- g. Task 203 Predictions (PM, FD, FL)
- h. Task 204 Fault Tree Analysis
- i. Task 205 Fault Identification Analysis
- j. Task 206 Fault Impact Analysis (PM and FD)
- k. Task 207 Transient Smoothing Analysis
- l. Task 301 Function Certification (PM, FD, FL)
- m. Task 302 Independent Verification & Validation (PM, FD, FL)
- n. Task 304 Factory Acceptance Test

The contractor shall tailor all tasks so that there is no duplication of work performed under tasks such as Failure Modes and Effects Analysis, Logistics Support Analysis, and Maintainability Prediction.

STATEMENT OF WORK FOR PM/FD/FL (CONT'D)
SAMPLE ONE

2.0 Applicable Documents

The following documents are applicable to PM/FD/FL to the extent specified herein. In case of conflict between the Contract Schedule, the SOW, and the applicable documents, the order of precedence in the SOW shall apply.

(Note: Here the documents as required by the particular program would inserted).

STATEMENT OF WORK FOR PM/FD/FL
SAMPLE TWO

PERFORMANCE MONITORING, FAULT DETECTION, FAULT LOCALIZATION REQUIREMENTS

1.0 Performance Monitoring, Fault Detection, Fault Localization Program.

The contractor shall develop and implement a PM/FD/FL program in accordance with the Statement of Work (SOW), the Prime Item Development Specification, and Section 3.0 of this Appendix to the SOW. The program shall be tailored to the needs of the project from the requirements of NUSC Report Number 8315A. The contractor shall also tailor each task so that there is no duplication of work performed under tasks such as Failure Modes and Effects Analysis, Logistics Support Analysis, and Maintainability Prediction.

2.0 Applicable Documents

The following documents are applicable to PM/FD/FL to the extent specified herein. In case of conflict between the Contract Schedule, the SOW, and the applicable documents, the order of precedence in the SOW shall apply.

3.0 Requirements

The contractor shall perform the tasks of NUSC Report 8315A as modified and tailored herein.

4.0 Software/Firmware and Hardware Development, Verification, Validation

The PM/FD/FL subsystem shall be developed, verified, and validated in accordance with the following sections of this SOW:

- a. Software and Firmware: Software Development requirements
- b. Hardware: Reliability, Maintainability, and Quality Assurance

APPENDIX D

SAMPLE CDRL ITEMS

CONTRACT DATA REQUIREMENTS LIST				SYSTEM ITEM	CONTRACTOR
ITEM NO.	TO/FROM	CATEGORY	DESCRIPTION	DATE OF SUBMITTAL	DATE OF SUBMITTAL
100			MAINTAINABILITY PREDICTIONS REPORT PN Mathematical Modeling Report	120 DAC	TBD
CANX/DI-MNTY-80827				30 DARC	
					TOTAL

BLOCK 3: DELETE 10.2.

BLOCK 4: THIS DATA SUBMITTAL MAY BE COMBINED WITH ELIN TBD AND TBD (FD, FL).

BLOCK 8: REVIEW IS FOR TECHNICAL CONTENT. APPROVAL WILL BE BASED UPON CONTRACTOR COMPLIANCE WITH SPECIFICATION REQUIREMENTS. ALLOW 45 DAYS FOR REVIEW. FINAL SHALL INCORPORATE ALL REVIEW COMMENTS AND CORRECTIONS AND SHALL REFLECT THE LATEST DESIGN CONFIGURATION.

ITEM NO.	TO/FROM	CATEGORY	DESCRIPTION	DATE OF SUBMITTAL	DATE OF SUBMITTAL
TBD			SCIENTIFIC AND TECHNICAL REPORTS Fault Impact, Transient Smoothing	180 DAC	TBD
DI-MISC-80048				30 DARC	
					TOTAL

BLOCK 2: (Cont'd) SUMMARY

DD FORM 1423	REPLACES EDITION OF 1 JAN 65, WHICH IS OBSOLETE.	DATE	APPROVED BY	NOTE
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APPENDIX E

APPLICABLE DATA ITEM DESCRIPTIONS

DATA ITEM DESCRIPTION REC'D SEP 18 1985

Form Approved
OMB No. 0704-0188
Exp. Date: Jun 30, 1986

1. TITLE HARDWARE DIAGNOSTIC TEST SYSTEM DEVELOPMENT PLAN		2. IDENTIFICATION NUMBER DI-ATTS-80005	
3. DESCRIPTION/PURPOSE 3.1 The Hardware Diagnostic Test System (HDTs) Development Plan describes the contractor's plan for developing and integrating a hardware fault diagnostic and test capability for system/subsystem/equipment. It provides a controlled statement of the contractor's plan for producing and developing the diagnostic software and hardware diagnostic test devices which satisfy the functional, performance, and			
4. APPROVAL DATE (YYMMDD) 850610	5. OFFICE OF PRIMARY RESPONSIBILITY (OPR) G/T213	6a. DTIC REQUIRED	6b. GIDEP REQUIRED
7. APPLICATION/INTERRELATIONSHIP 7.1 The Hardware Diagnostic Test System Development Plan provides the contractor with the means to coordinate, control, and monitor progress of the development effort. It provides the Government with knowledge of the schedule, organization and resource allocation planned by the contractor. It is a basic tool with which the Government can monitor the contract work effort. 7.2 This data item description (DID) satisfies the requirements of paragraph 5.1, DOD-STD-1701(NS)			
8. APPROVAL LIMITATION		9a. APPLICABLE FORMS	9b. AMSC NUMBER G3611
10. PREPARATION INSTRUCTIONS 10.1 <u>Source document.</u> This applicable issue of the document cited herein, including its approval date and dates of any applicable amendments and revisions, shall be as reflected in the contract. 10.2 The HDTs development plan shall consist of ten sections with appropriate subsections. The format shall be as follows. <div style="margin-left: 40px;"> Section I - <u>Introduction</u> Section II - <u>Organization and Responsibility</u> Section III - <u>Management and Technical Controls</u> Section IV - <u>Resources</u> <div style="margin-left: 20px;"> 4.1 Personnel 4.2 Training 4.3 Data Processing Equipment </div> Section V - <u>Software Development Schedule</u> </div>			

3. DESCRIPTION/PURPOSE (Cont'd)

operational requirements of the system/subsystem/equipment. It is used to approve the contractor's approach for a Hardware Diagnostic Test System (HDTIS), and to monitor and evaluate the contractor's progress while developing the HDTIS.

10. PREPARATION INSTRUCTIONS (Cont'd)

- Section VI - Monitoring and Reporting
- Section VII - Documentation
- Section VIII - Development Approach
 - 8.1 Engineering Practices
 - 8.2 Operating Practices
- Section IX - Development and Test Tools
- Section X - Security Controls and Requirements

10.3 The content of each section shall be as follows.

10.3.1 Section I. Introduction. This section shall describe the scope, purpose, application and authority of the development effort. This should include a brief overview of the management philosophy and methodology that will be used on the project.

10.3.2 Section II. Organization and Responsibility. This section shall describe the organization, responsibilities and structure of the groups that will be designing, producing and testing all segments of the software system. It shall also identify the name and management position of each supervisor.

10.3.3 Section III. Management and Technical Controls. This sections shall describe the management and technical controls that will be used during development, including controls for insuring that all performance and design requirements have been identified and implemented.

10.3.4 Section IV. Resources.

10.3.4.1 Personnel. This section shall identify the level of manpower allocated to each task shown in the development schedule, including numbers, duration of assignment, and required skills. This includes administrative and logistic support personnel. If known, personnel assigned to software development tasks shall be listed by name. This section shall also identify security clearance requirements and plans for obtaining the necessary security clearances for personnel working on the software system (if applicable).

10.3.4.2 Training. This section shall identify training required for people working on the project and dates by which the training must be completed.

10. PREPARATION INSTRUCTIONS (Cont'd)

10.3.4.3 Data Processing Equipment. This section shall identify requirements for the use of data processing equipment to support the development of computer programs and their subsequent testing. It shall also describe the plan for assuring that the necessary hardware is available at the appropriate times.

10.3.5 Section V. Software Development Schedule. This section shall present a graphic and narrative description of the scheduled events and milestones of the software development effort. The schedule will be updated to reflect additional detail as the project moves through successive phases of the development cycle. By Preliminary Design Review, this section shall include a development schedule for each computer program and data base. The graphic description shall be a chart identifying schedules for the following:

- a. All deliverables;
- b. Preparation of management and test plans;
- c. All levels of testing;
- d. Reviews, including major reviews and other internal milestones;
- e. Transition to life-cycle support activity.

The chart should illustrate a relationship with hardware schedules. Critical paths shall also be identified.

10.3.6 Section VI. Monitoring and Reporting. This section shall describe the procedure for monitoring and reporting the status of program development. It shall also describe the manner in which problems and recommended solutions to problems will be reported.

10.3.7 Section VII. Documentation. This section shall describe the approach for developing computer program documentation and will identify the documentation that will be produced. This shall include the plan for developing test-planning documentation, the Software Requirements Specification, the System/Subsystem Specification, the Program Specification, Software Manuals and any other documentation.

10.3.8 Section VIII. Development Approach.

10.3.8.1 Engineering Practices. This section shall describe the engineering practices that will be applied to the development of software. These practices include standards, conventions, procedures, rules for programming, design and other disciplines affecting development. At a minimum, procedures for implementing the following practices shall be described:

- a. Programming and data base standards;
- b. Top-down design methodology;
- c. Design walk-throughs.

PREPARATION INSTRUCTIONS (Cont'd)

10.3.8.2 Operating Practices. This section shall describe the operating practices that will be applied to the development of software. These include the following;

- a. Use of Unit Development Folders;
- b. Techniques for ensuring that all performance and design requirements have been implemented;
- c. Means of ensuring modularity, ease of modification, and capacity for computer program growth;
- d. Methods and procedures for collecting, analyzing, monitoring and reporting on the timing of time-critical computer programs;
- e. Means for ensuring that the software/data processors/peripheral equipment interfaces are adequate;
- f. Criteria for determining when a development unit should be entered into configuration control;
- g. Means of controlling master copies of computer programs, data bases and associated documentation during development (including their relationship to the Configuration Management Plan);
- h. Rules for interface definition.

10.3.9 Section IX. Development and Test Tools. This section shall identify the special tools and techniques that will be used during development and testing of the computer programs. Some examples are as follows:

- a. Special simulation;
- b. Data reduction;
- c. Code optimizers;
- d. Code auditors;
- e. Special utility programs;
- f. Software security test tools.

10.3.10 Section X. Security Control and Requirements. This section shall identify security controls that will be used during software development (e.g., physical security, document access controls, computer access controls, etc.). It shall also describe the method of implementing and maintaining the security controls. It shall also identify and unique security problems and installation security requirements.

DATA ITEM DESCRIPTION		2. IDENTIFICATION NO(S).	
		AGENCY	NUMBER
1. TITLE DESIGN REVIEW DATA PACKAGE		NSA	DI-E-5423
3. DESCRIPTION/PURPOSE 3.1 The data packages are required by the Government to permit adequate preparation for each design review prior to the review meeting.		4. APPROVAL DATE 1977 May 02	
		5. OFFICE OF PRIMARY RESPONSIBILITY NSA-R41	
		6. DDC REQUIRED	
		8. APPROVAL LIMITATION	
7. APPLICATION/INTERRELATIONSHIP 7.1 To be used on contracts which require formal technical reviews and audits.		9. REFERENCES (Mandatory as cited in block 10) MIL-STD-1521	
		MCSL NUMBER(S)	
10. PREPARATION INSTRUCTIONS 10.1 Data packages shall be provided for design review meetings to be held on the program and submitted as indicated on DD Form 1423. The data packages shall be designed to provide adequate preparation information for design reviews organized in accordance with MIL-STD-1521 and Appendices B, C, D, and G. The detail contents of each package shall include, but not be limited to, the material required for the subject design review, an agenda, and a status of pertinent (if any) action items from previous design reviews or other meetings.			

DD FORM 1664

S/N-0102-019-4000 PLATE NO. 19448

PAGE 1 OF 1 PAGES
D-6617

U.S. GOVERNMENT PRINTING OFFICE: 1977-703-030/4923

DATA ITEM DESCRIPTION		2. IDENTIFICATION NO(S)	
		AGENCY	NUMBER
1. TITLE Configuration Management Plan (CMP)		USAF	DI-E-3108/ C-118-1
3. DESCRIPTION/PURPOSE This plan is prepared by the contractor to describe his assignment of responsibilities organizationally and the procedures used in his accomplishment of the specific configuration management requirement as stated in the contract. It is not to be used as a contractual requirement in lieu of the statement of work.		4. APPROVAL DATE 26 February 1971	
		5. OFFICE OF PRIMARY RESPONSIBILITY AFSC	
		6. DDC REQUIRED	
		8. APPROVAL LIMITATION	
7. APPLICATION/INTERRELATIONSHIP Obtained as part of the validation phase final report. When a validation phase is not accomplished, the CMP will be a requirement of the full-scale development contract. Not to be used on follow on contracts where the contractor's configuration management organization and procedures have been satisfactorily demonstrated on prior contracts. This DID may be modified and used on competitive RFPs to acquire information for source selection. When used in this manner, only an abbreviated plan will be acquired. By the same token, when this plan is procured (on other than validation contracts) it should be modified to delete source selection requirements.		9. REFERENCES (Mandatory as cited in block 10) MIL-STD-483 (USAF)	
		MCBL NUMBER(S)	
10. PREPARATION INSTRUCTIONS The contractor shall describe in a configuration management plan, the organizational responsibilities and procedures used in the implementation of the configuration management requirements as stated in the contract. The configuration management plan shall be prepared in accordance with the criteria set forth in Appendix I of MIL-STD-483 (USAF).			

DATA ITEM DESCRIPTION		Form Approved OASD No 0704-0184	
1. TITLE Maintainability Modeling Report		2. IDENTIFICATION NUMBER DI-MNTY-80825	
3. DESCRIPTION / PURPOSE 3.1 To describe and show the development of a maintainability model for making numerical maintainability apportionments to various functions and levels of hardware throughout an item (system, subsystem, equipment) and to evaluate the maintainability of an item based on its maintainability design characteristics.			
4. APPROVAL DATE (YYMMDD) 890530	5. OFFICE OF PRIMARY RESPONSIBILITY (OPR) 17	6a. DTIC APPLICABLE	6b. CIDEP APPLICABLE
7. APPLICATION / INTERRELATIONSHIP 7.1 This DID contains the content and format requirements of the data item generated by paragraph 201.2 of Task 201 of MIL-STD-470B. This DID is applicable to contracts which contain the requirements for Task 201 "Maintainability Modeling," of MIL-STD-470B. 7.2 This DID supersedes DI-R-7106.			
8. APPROVAL LIMITATION		9a. APPLICABLE FORMS	9b. AMSC NUMBER F4710
10. PREPARATION INSTRUCTIONS 10.1 <u>Reference documents.</u> The applicable issue of the documents cited herein, including their approval dates and dates of any applicable amendments, notices, and revisions, shall be as specified in the contract. 10.2 <u>Content.</u> The report shall contain the Maintainability model(s) developed in accordance with paragraph 201.2 of Task 201 "Maintainability Modeling" of MIL-STD-470 as tailored to the particular needs of the acquisition program. 10.3 <u>Format.</u> The report shall be prepared in accordance with ANSI Z39.18, "Scientific and Technical Reports: Organization, Preparation, and Production."			
11. DISTRIBUTION STATEMENT DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.			

DATA ITEM DESCRIPTION			Form Approved OMB No. 0704-0188	
1. TITLE Maintainability Allocations Report		2. IDENTIFICATION NUMBER DH-MINTY-80826		
3. DESCRIPTION / PURPOSE 3.1 To document the quantitative and qualitative maintainability requirements developed for each component item of the approved hardware breakdown structure derived to meet the end item requirements.				
4. APPROVAL DATE (YYMMDD) 890530	5. OFFICE OF PRIMARY RESPONSIBILITY (OPR) 17	6a. DTIC APPLICABLE	6b. GIDEP APPLICABLE	
7. APPLICATION / INTERRELATIONSHIP 7.1 This DID contains the content and format requirements of the data item generated by paragraph 202.2 of Task 202 of MIL-STD-470B. The DID is applicable whenever Task 202 is called out as part of an acquisition program. System/subsystem/equipment level quantitative maintainability requirements must be broken down to appropriate subsystem/equipment/unit/subunit levels as necessary to establish requirements for designers and subcontractors. 7.2 This DID supersedes DI-R-7107.				
8. APPROVAL LIMITATION		9a. APPLICABLE FORMS		9b. AMSC NUMBER F4711
10. PREPARATION INSTRUCTIONS 10.1 <u>Reference documents</u> . The applicable issue of the documents cited herein, including their approval dates and dates of any applicable amendments, notices, and revisions, shall be as specified in the contract. 10.2 <u>Content</u> . The Maintainability Allocations Report shall include the information required by paragraph 202.2 of Task 202 of MIL-STD-470, as tailored for the particular acquisition. The report shall provide the results and describe the process of allocating maintainability requirements to each component end item. 10.3 <u>Format</u> . The format of the report shall be in accordance with ANSI Z39.18, "Scientific and Technical Reports: Organization, Preparation, and Production".				
11. DISTRIBUTION STATEMENT DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.				

DATA ITEM DESCRIPTION			Form Approved OMB No. 0704-0188	
1. TITLE Maintainability Predictions Report		2. IDENTIFICATION NUMBER DI-MNTY-80827		
3. DESCRIPTION / PURPOSE 3.1 To provide the description and documentation of the maintainability prediction made by the contractor. To make a determination of whether or not the proposed design is consistent with maintainability requirements.				
4. APPROVAL DATE (YYMMDD) 890530	5. OFFICE OF PRIMARY RESPONSIBILITY (OPR) 17	6a. DTIC APPLICABLE	6b. GIDEP APPLICABLE	
7. APPLICATION / INTERRELATIONSHIP 7.1 This DID contains the content and format requirements of the data item generated by paragraph 203.2 of Task 203 of MIL-STD-470B. The content of this report shall be included in the Maintainability Predictions Report of MIL-HDBK-472 when that has been designated as the basis for Task 203 of MIL-STD-470B. 7.2 This DID supersedes DI-R-7108.				
8. APPROVAL LIMITATION		9a. APPLICABLE FORMS		9b. AMSC NUMBER F4712
10. PREPARATION INSTRUCTIONS 10.1 <u>Reference documents</u> . The applicable issue of the documents cited herein, including their approval dates and dates of any applicable amendments, notices, and revisions, shall be as specified in the contract. 10.2 <u>Content</u> . The Maintainability Predictions Report shall contain the following detail as tailored for the particular acquisition: a. Assumptions used in the prediction process. b. Identification of the prediction procedure used. c. Prediction results to the appropriate levels. 10.3 <u>Format</u> . The format of the report shall be in accordance with ANSI Z39.18, "Scientific and Technical Reports: Organization, Preparation, and Production".				
11. DISTRIBUTION STATEMENT DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.				

DATA ITEM DESCRIPTION

REC'D DEC 2 1985

Form Approved
OASD No. 0704-0188
Exp. Date: Jun 30, 1986

1. TITLE		2. IDENTIFICATION NUMBER	
Scientific and Technical Reports Summary		DI-MISC-80048	
3. DESCRIPTION/PURPOSE			
<p>3.1 Technical reports are acquired to provide the scientific and technical community a description of the precise nature and results of research, development, test, and evaluation (RDT&E) accomplished. Technical reports may be definitive for the subject presented, exploratory in nature, or an evaluation of critical subsystem or of technical problems.</p>			
4. APPROVAL DATE	5. OFFICE OF PRIMARY RESPONSIBILITY (OPR)	6a. DTIC REQUIRED	6b. GIDEP REQUIRED
850911	DELNV		
7. APPLICATION/INTERRELATIONSHIP			
<p>7.1 This Data Item Description contains the data format and content preparation instructions for the data product generated by the specific and discrete task requirements for this data included in the contract.</p> <p>7.2 This Data Item Description shall be used in preparing all ongoing interim or final Scientific and Technical Reports Summary. The purpose of these report summaries is to present management with a concise description of the scientific and technical findings and accomplishments during the reporting period.</p>			
8. APPROVAL LIMITATION	9a. APPLICABLE FORMS	9b. AMSC NUMBER	
		A3670	
10. PREPARATION INSTRUCTIONS			
<p>10.1 <u>Contract</u>. This Data Item Description is generated by the contract which contains a specific and discrete work task to develop this data product.</p> <p>10.2 <u>Format</u>. The Scientific and Technical Reports Summary shall be in contractor format.</p> <p>10.3 <u>Contents</u>. The level of detail of the Scientific and Technical Reports Summary shall be adequate for non-specialists in the subject matter. When appropriate, specific references should be made to more detailed materials. The content of the Scientific and Technical Report Summary shall consist of the following:</p> <ul style="list-style-type: none"> (a) Task objectives. (b) Technical problems. (c) General methodology (e.g., literature review, lab experiment, survey, etc). (d) Technical results. (e) Important findings and conclusions. 			

Scientific and Technical Reports Summary (Cont'd)

Block 7 APPLICATION/INSTRUCTIONS (Cont'd)

7.2 (Cont'd) The types of scientific and technical report summaries and their frequencies are specified in the DD Form 1423

7.3 This Data Item Description shall be applicable in contracts when DI-S-4057 is used.

Block 10 PREPARATION INSTRUCTIONS (Cont'd)

10.3 (Cont'd)

- (f) Implications for further research
- (g) Significant hardware development
- (h) Special comments

10.4 Cover Page - The heading or cover page of each report summary shall contain the following information:

- (a) Procuring Activity Designated Order Number
- (b) Name of Contractor
- (c) Contract Number
- (d) Effective Date of Contract
- (e) Expiration Date of Contract
- (f) Reporting Period
- (g) Principal Investigator and Phone No.
- (h) Project Scientist or Engineer and Phone No
- (i) Short Title of Work

10.4.1 Additionally, each report produced will have prominently displayed on the cover page, a notice of disclaimer worded as follows:

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the Government.

10.4.2 Scientific and Technical Reports which are sponsored by other than the procuring activity shall have the following on the front cover:

Scientific and Technical Reports Summary (Cont'd)

Block 10 PREPARATION INSTRUCTIONS (Cont'd)

Sponsored by
(Sponsor's Identification)

(Sponsor's Designated) Order No. _____

Monitored by _____ Under Contract# _____

10.5 Reports shall be reproduced only by processes which provide black on white copy sufficiently clear and sharp for further reproduction when required. Ditto, hectograph, color, and other reproduction processes not reproducible photographically or xerographically are not acceptable.

DATA ITEM DESCRIPTION	2. IDENTIFICATION NO.	
TITLE PROCEDURES, TEST	AGENCY NAVY-SE	NUMBER UDI-T-237325
DESCRIPTION/PURPOSE This data item is used to describe a contractor's test procedure and how he intends to determine compliance with specification requirements.	4. APPROVAL DATE 74 Oct 23	
	5. OFFICE OF PRIMARY RESPONSIBILITY SEA 9833	
	6. DDC REQUIRED	
	8. APPROVAL LIMITATION	
7. APPLICATION/INTERRELATIONSHIP Application will be as specified by the contract data requirements list. This item may be used whenever tests are required.	9. REFERENCES (Authority as cited in Block 10)	
	MCSL NUMBER(s)	

10. PREPARATION INSTRUCTIONS

10.1 The test procedures shall be typed in contractor or commercial format on 8"x10 1/2" sheets.

10.2 The test procedures shall cover in detail the plan and procedures for accomplishment of the tests specified in the contract schedule and specifications referenced therein or in Block 16 of the DD Form 1423, Contract Data Requirements List, data item requiring these procedures and shall specifically cover or contain the following as applicable:

- a. Title
- b. Index
- c. Identification of item being tested (serial number)
- d. Identification number of test procedure
- e. Hardware configuration
- f. Test prerequisites
- g. Report form
- h. Date, time and duration of test
- i. Proposed test(s)
- j. Preoperational checklist
- k. The purpose of the test(s)

PROCEDURES, TEST (Continued)

- l. Description of test
- m. The specification paragraph(s) to which the test(s) will prove compliance.
- n. Detailed step-by-step procedure (may be referenced to test number and test title in Government documents)
- o. Test schedule (operating profile, setpoints, stabilization time, data points)
- p. The test equipment utilized.
- q. Approvals, authorities and responsibilities
- r. Sketches or photographs of test set-up
- s. Facilities required for test
- t. Test equipment requirements (major and special)
- u. Methods of measurement(s)
- v. Logistics equipment requirements (spare test hardware)
- w. Method of control of sub-contractor's efforts and their procedures.
- x. Applied instrumentation and data recording equipment
- y. Data sheets (when required by a specification) for which the results are able to be correlated to the item tested.
- z. Types of data to be recorded (parameters, ranges, accuracies, type readout, and quantities)
- aa. Results (comparison of test data to acceptance standard)
- bb. Accept/reject criteria for test acceptance.
- cc. Personnel required
- dd. Special resource requirements
- ee. References to specs, standards, tech manuals, other test procedures and reports, change orders, notices, and other references not specific to the test but included for information only.

In addition to the requirements of paragraph 10.2, the production test edures shall cover cleaning/refurbishing of test equipment and, if applicable, relationship for and during availability test(s).

DATA ITEM DESCRIPTION		Form Approved OMB No 0704-0188	
1. TITLE Data Collection, Analysis and Corrective Action System, Reports		2. IDENTIFICATION NUMBER DI-MNTY-80824	
3. DESCRIPTION/PURPOSE 3.1 This data is used to aid maintainability design, identify corrective action tasks and to evaluate test results. The reports generated shall consist of tabulations and analyses of all maintenance actions occurring through the reporting period as well as remedial actions proposed by the contractor to eliminate maintainability deficiencies (and fault detection/isolation deficiencies).			
4. APPROVAL DATE (YYMMDD) 890530	5. OFFICE OF PRIMARY RESPONSIBILITY (OPR) 17	6a. OTC APPLICABLE	6b. GIDEP APPLICABLE
7. APPLICATION/INTERRELATIONSHIP 7.1 This DID contains the content and format requirements of the data item generated by paragraph 104.2 of Task 104 of MIL-STD-470B. This DID is applicable when Task 104, "Data Collection, Analysis and Corrective Action system" of MIL-STD-470B is called out as part of the acquisition program. This DID should be prepared in conjunction with the "Maintainability Demonstration Reports" called out in MIL-STD-471A. 7.2 This DID supersedes DI-R-7105.			
8. APPROVAL LIMITATION		9a. APPLICABLE FORMS	9b. AMSC NUMBER F4709
10. PREPARATION INSTRUCTIONS 10.1 Reference documents. The applicable issue of the documents cited herein, including their approval dates and dates of any applicable amendments, notices, and revisions, shall be as specified in the contract. 10.2 Content. The report content shall describe the results of the "Data Collection, Analysis and Corrective Action System". a. The report shall include subcontractor, vendor data, as applicable. b. Data collected, analyzed and documented should be representative of the information elements contained below: <ul style="list-style-type: none"> (1) A maintenance event identification number. (2) Maintenance task identification, keyed to each maintenance event (detection, isolation, removal, checkout, etc.) (3) Date on which the maintenance event took place. (4) Identification of the location where the maintenance event took place. <p style="text-align: right;">(Continued on Page 2)</p>			
11. DISTRIBUTION STATEMENT DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.			

Block 10, Preparation Instructions (Continued)

- (5) Identification of system, subsystem, assembly, printed circuit card on which maintenance was performed.
- (6) Maintenance time necessary for corrective actions (or maintenance manhours, where appropriate).
- (7) Deficiencies found/corrective actions taken.
- (8) Diagnostic effectiveness data (percent of fault detectable, isolatable, false alarm rates, etc.).
- (9) Logistic Support Analysis (LSA) applicable data.

10.3 Format. The report shall be prepared in accordance with ANSI Z39.18, "Scientific and Technical Reports: Organization, Preparation, and Production".

DATA ITEM DESCRIPTION		2. IDENTIFICATION NO(S).	
		AGENCY	NUMBER
1. TITLE Testability Program Plan		DOD	DI-T-7198
3. DESCRIPTION/PURPOSE 3.1 This plan identifies the performing activity approach for implementing a Testability Program in accordance with MIL-STD-2165.		4. APPROVAL DATE 29 January 1985	
		5. OFFICE OF PRIMARY RESPONSIBILITY NAVY-EC	
		6. DOC REQUIRED	
		5. APPROVAL LIMITATION	
7. APPLICATION/INTERRELATIONSHIP 7.1 These data are to be used to define a Testability Program Plan. 7.2 This DID may be used for all electronic system and equipment development programs. 7.3 This DID satisfies the data requirements of Task 101 of MIL-STD-2165.		8. REFERENCES (Mandatory as cited in block 10) MIL-STD-2165	
		MCSL NUMBER AMSC NO. N3424	
10. PREPARATION INSTRUCTIONS 10.1 The applicable issue of the documents cited herein, including their approval dates and applicable amendments and revisions, shall be as reflected in the contract. 10.2 Contractor's format is acceptable. 10.3 A Testability Program Plan shall be prepared in accordance with MIL-STD-2165, Task 101 and include the following elements, with the range and depth of information for each element tailored to the acquisition phase: 10.3.1 A description of the work to be accomplished for each testability task included in the contractual requirements. 10.3.2 The time phasing of each task and its relationship to other tasks, particularly maintainability tasks. 10.3.3 Identification of a single organizational element within the performing activity which has overall responsibility and authority for implementation of the testability program. 10.3.4 Identification of data interfaces between the organizational element responsible for testability and other related elements.			

Testability Program Plan

10. Preparation Instructions (Cont'd)

- 10.3.5 Identification of the method by which testability requirements will be integrated with other design requirements and disseminated to design personnel and subcontractors.
- 10.3.6 Identification of testability design guides and testability analysis procedures to be used.
- 10.3.7 Description of procedures for scheduling, conducting and documenting testability design reviews.
- 10.3.8 Identification of testability submissions and their review, verification and utilization.
- 10.3.9 Description of procedures for identifying testability-related problems and assuring corrective action.
- 10.3.10 Description of procedures and controls for assuring that each subcontractor's testability practices are consistent with overall system or equipment requirements.

DATA ITEM DESCRIPTION		2. IDENTIFICATION NO(S).	
		AGENCY	NUMBER
1. TITLE Testability Analysis Report		DOD	DI-T-7199
3. DESCRIPTION/PURPOSE 3.1 This report documents the results of the testability requirements, design and evaluation tasks of MIL-STD-2165.		4. APPROVAL DATE 29 January 1985	
		5. OFFICE OF PRIMARY RESPONSIBILITY NAVY-EC	
		6. DDC REQUIRED	
		8. APPROVAL LIMITATION	
7. APPLICATION/INTERRELATIONSHIP 7.1 These data are to be used to evaluate the level of testability incorporated in a design. 7.2 This DID may be used for all electronic system and equipment development programs. 7.3 This DID satisfies the data requirements of Tasks 201, 202 and 203 of MIL-STD-2165.		9. REFERENCES (Mandatory as cited in block 10) MIL-STD-2165	
		MCSL NUMBER(S) AMSC NO. N3425	
10. PREPARATION INSTRUCTIONS 10.1 The applicable issue of the documents cited herein, including their approval dates and applicable amendments and revisions, shall be as reflected in the contract. 10.2 Contractor's format is acceptable. 10.3 The content of the Testability Analysis Report shall include the following: 10.3.1 <u>General</u> 10.3.1.1 A brief description of the system's functional operation. 10.3.1.2 A brief description of the functional operation of each item. 10.3.1.3 A description of system maintenance and support concept. 10.3.2 <u>Testability Requirements Analysis (MIL-STD-2165, Task 201)</u> 10.3.2.1 Description of methodology used to trade-off alternative diagnostic concepts, including varying degrees of built-in test, automatic test equipment and manual test. 10.3.2.2 Results of diagnostic trade-offs, including the impact of each alternative on readiness, life cycle costs, manpower and training.			

Testability Analysis Report

10. Preparation Instructions (Cont'd)

- 10.3.2.3 Description of the selected system diagnostic concept including recommended testability requirements for the system specification.
- 10.3.2.4 Description of methodology used to allocate system testability requirements to each item; recommended testability requirements for each item.
- 10.3.3 Preliminary Testability Design Analysis (MIL-STD-2165, Task 202)
 - 10.3.3.1 Description of system built-in test functional design and system partitioning used to enhance testing.
 - 10.3.3.2 For each item to be included in this analysis, a description of testability features incorporated (compatibility, observability, controllability, partitioning, etc.), BIT functional design and BIT interfaces to system BIT and to external test.
 - 10.3.3.3 For each item to be included in the Inherent Testability Assessment, recommended weighting factors and scoring method for each testability criteria in the checklist.
 - 10.3.3.4 For each item to be included in the Inherent Testability Assessment, a filled-in checklist and the calculated inherent testability.
 - 10.3.3.5 Description of methodologies, models and tools to be used in predicting built-in test fault detection and fault isolation effectiveness.
- 10.3.4 Detailed Testability Design Analysis (MIL-STD-2165, Task 203)
 - 10.3.4.1 For each item to be included in this analysis, a definition of predominant failure modes to be tested, a prediction of built-in test fault detection and fault isolation effectiveness and identification of areas which require additional testing.
 - 10.3.4.2 Prediction of built-in test fault detection, fault isolation and false alarm characteristics at the system level.
 - 10.3.4.3 Estimation of costs associated with the incorporation of built-in test and testability features, including developmental costs and recurring costs.

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